IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:	Examiner: Parker, Kenneth
Rong-Chang LIANG, et al.	Art Unit: 2871
Application Serial No. 09/759,212	Attorney's Docket No. 26822-0003
Filed: January 11, 2001	**Customer No. 25213**
For: **TRANSMISSIVE OR REFLECTIVE LIQUID CRYSTAL DISPLAY AND NOVEL PROCESS FOR ITS MANUFACTURE**	

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RESPONSE TO OFFICE ACTION

MAIL STOP FEE AMENDMENT
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

Dear Sir:

This is in response to the Office Action mailed on May 28, 2003. A one month extension of time is hereby requested. Please amend the application as follows:

AMENDMENTS TO THE SPECIFICATION:

On page 5, replace the second paragraph with the following paragraph. (A change has been made in line 2.):

Yet another aspect of the present invention relates to the sealing of the microcups filled with the LC ~~preferable,~~ **preferably** with guest dye(s). Sealing can be accomplished by a variety of ways. Preferably, it is accomplished by dispersing into the LC phase before the filling step, a sealant composition containing a thermoplastic or thermoset precursor. The sealant composition is immiscible with the LC and has a specific gravity lower than that of the LC. After filling, the thermoplastic or thermoset precursor phase separates and forms a supernatant layer at the top of the LC. The sealing of the microcups is then conveniently accomplished by hardening the precursor layer by solvent evaporation, interfacial reaction, moisture, heat, or radiation. UV radiation is the preferred method to seal the microcups, although a combination of two or more curing mechanisms as described above may be used to increase the throughput of sealing. Alternatively, the sealing can be accomplished by overcoating the LC with a sealant composition containing the thermoplastic or thermoset precursor. The solvent used in the sealant composition is critical. Preferably, it is immiscible with the LC and has a specific gravity lower than that of the LC. It is also important to control the surface tension and viscosity of the sealant composition to ensure a good coating uniformity. The sealing is then accomplished by hardening the sealant composition by solvent evaporation, interfacial reaction, moisture, heat, radiation, or a combination of curing mechanisms. These sealing processes are also unique features of the present invention.

On page 6, replace the first paragraph with the following paragraph (A change has been made in lines 8 and 9.):

Yet another aspect of the present invention relates to the absence of the hysteresis of the LC displays. The LC displays of the present invention consist of substantially monodispersed microcups filled with liquid crystals and preferably a guest dye. The composition of the microcups is optimized such that the isotropic refractive index of the cups is matched to the ordinary refractive index of the LC. In a manner

similar to conventional PDLC displays, the LC displays of the present invention strongly scatter light in the absence of an electric field (the "off state"). When a voltage difference is applied between the two electrodes, the electric field aligns the LC ~~and~~ **which** substantially reduce**s** scattering power and allow**s** light to transmit through the "on state". However, unlike the PDLC displays, the LC displays of this invention reach the maximum optically clear state at a much lower voltage and, when the applied voltage is withdrawn, reverts back to the original "off" state without undesirable hysteresis. The low operation voltage, fast response time, and the absence of hysteresis of the displays of the present invention are critical for high quality display applications where low power consumption, reproducible gray scales and video rate are highly desirable.

On page 11, replace the second paragraph with the following paragraph (A change has been made in line 3.):

The thermoplastic or thermoset precursor (32) for the preparation of the microcups (33) may be multifunctional acrylate or methacrylate, vinyl ether, epoxide and their oligomers, polymers and the like. Multifunctional acrylate and ~~their~~ **its** oligomers are the most preferred. A combination of multifunctional epoxide and multifunctional acrylate is also very useful to achieve desirable physico-mechanical properties. A crosslinkable oligomer imparting flexibility, such as urethane acrylate or polyester acrylate, is usually also added to improve the flexure resistance of the embossed microcups. The composition may contain polymer, oligomer, monomer and additives or only oligomer, monomer and additives. The glass transition temperatures (or Tg) for this class of materials usually range from about -70°C to about 150°C, preferably from about -20°C to about 50°C. The microembossing process is typically carried out at a temperature higher than the Tg. A heated male mold or a heated housing substrate against which the mold presses may be used to control the microembossing temperature and pressure.

On page 16, replace the second paragraph with the following paragraph (A change has been made in line 3.):

Alternatively, the LC and the sealant composition may be coated sequentially into the microcups. Thus, the sealing of the microcups may be accomplished by overcoating a thin layer of **a** thermoplastic or ~~a~~ thermoset precursor composition which is curable by radiation, heat, moisture or interfacial reactions and curing on the surface of the filled microcups. Interfacial polymerization followed by UV curing is very beneficial to the sealing process. Intermixing between the LC layer and the overcoat can be significantly suppressed by the formation of a thin barrier layer at the interface by interfacial polymerization. The sealing is then completed by a post curing step, preferably by UV radiation. To further reduce the degree of intermixing, it is highly desirable that the specific gravity of the overcoating is lower than that of the LC. Volatile organic solvents may be used to adjust the viscosity and the thickness of the coatings. When a volatile solvent is used in the overcoat, it is preferred that it is immiscible with the LC or the dye and has a specific gravity lower than that of the LC phase. The two-step overcoating process is particularly useful when the dye used is at least partially soluble in the sealant layer. To further reduce the degree of intermixing between the sealant layer and the LC phase, the filled microcup array may be chilled before overcoating of the sealant layer.

On page 19, replace point 1, line 1, with the following line(s):

1. Coat a layer of **thermoplastic or** thermoset precursor (80) on a conductor film (81).

On page 21, after "Example 1, Preparation of Microcups by Microembossing", replace the first paragraph with the following paragraph (Changes have been made in lines 1, 5, 6 and 8.):

The composition shown in Table 1 was **coated with a** Myrad bar #6 coated onto a 2mil PET film precoated with an ITO conductor layer from Sheldahl (Northfield, MN). A pre-patterned (4x4x4 microns) cobalt nickel male mold and a mold release Frekote 700-NC from Henkel were used for microembossing. The coating thickness was controlled to be about 5 microns. The coated film ~~is~~ **was** then embossed by the stencil using a pressure roller at 90 °C. The coating ~~is~~ **was** then UV-cured for about 1 minute

through the Mylar film using a Cure Zone exposure unit (ADAC Technologies) equipped with a metal fluoride lamp with an intensity of 80 mW/cm^2 at 365 nm. The embossed film ~~is~~ **was** then released from the mold to reveal well-defined (4x4x4 microns) microcups. The microembossing was carried out using the GBC Laminator at 90 °C.

On page 23, after "Example 3, Preparation of Microcups by Microembossing" replace the first paragraph with the following paragraph (A change has been made in line 3.):

The composition shown in Table 3 was laminated using a pressure roller between a 2 ml PET film precoated with an ITO conductor layer, and a pre-patterned (4x4x4 microns) cobalt nickel mold. The PET/ITO film was treated **with** a corona discharge (Electro-Technic Products, Model BD-10A, Chicago, IL) for 5 sec. The cobalt nickel mold was pretreated with a mold release Frekote 750-NC. The coating was then UV cured for 1 min through the PET/ITO film. The embossing film was then released from the mold to reveal well-defined (4x4x4 microns) microcups with a thickness of 5.5 microns as measured by a Mituyoto thickness gauge.

On page 25, after "Example 6, Preparation of Filled Microcups with Liquid Crystal Solution Containing Black Dichroic Dye Mixture" replace the first paragraph with the following paragraph (Changes have been made in line 4.):

The microcups generated in Example 3 were washed with hexanes, then with MEK, and oven dried (66 °C) for 10 min. A black dichroic dye mixture was prepared by mixing three dichroic dyes, Blue AB2, Red AR1, and Yellow AG1 (Funktionfluid Gmb, Germany), together. A liquid crystal BL006 (E. Merck Co., Germany) solution containing 2wt% black dichroic dye mixture and 1wt% Silwet L7608 (OSi Specialties) was mixed with 9 times volume of MPK, and the resulting solution was coated on microcup using Myrad bar #16. Excess solvent on the microcup was evaporated in oven (66 °C) for 10 min.

On page 25, after "Example 7, Sealing the Microcups by a Two-step (Overcoating) Process" replace the first paragraph with the following paragraph (Changes have been made in lines 3 and 7.):

A 10% solution of Vistalon 0106 (Exxon Mobil Chemicals) in Isopar E (Exxon Chemical) was coated onto a BL006-filled microcup sample prepared in Example 4, 5 ~~and~~ or 6. The coating layer was uniform and transparent. By using a #3 Myrad bar, a sealing polymer layer with the weight coverage of 0.39 mg/in^2 was obtained and the thickness of the sealing polymer layer was estimated to be 0.7 μ. By using a #8 Myrad bar, a sealing polymer layer with the weight coverage of 0.75 mg/in^2 was obtained and the thickness of the sealing polymer layer was estimated to be 1.3 μ. The density of Vistalon 0106 ~~is~~ was about 0.9 g/cm^3.

On page 26, after "Example 8, Sealing the Microcups by a Two-step (Overcoating) Process" replace the first paragraph with the following paragraph (Changes have been made in lines 4 and 9.):

Following the same procedure of Example 7, the microcups were sealed by coating a 10% solution of a carboxylated acrylic copolymer, Amphomer 28-4910 (National Starch) in 2-propanol onto the BL006-filled microcups as prepared in Example 5. The coating layer ~~is~~ was uniform and transparent. By using a #3 Myrad bar, a sealing polymer layer with the weight coverage of 0.44 mg/in^2 was obtained and the thickness of the sealing polymer layer was estimated to be 0.6 μ. By using a #8 Myrad bar, a sealing polymer layer with the weight coverage of 1.0 mg/in^2 was obtained and the thickness of the sealing polymer layer was estimated to be 1.3 μ. The density of Amphomer 28-4910 ~~is~~ was about 1.2 g/cm^3.

On page 26, after "Example 9, Traditional Polymerization Induced Phase Separation PDLC Display" replace the first paragraph with the following paragraph (A change has been made in line 4.):

For comparison, a traditional polymerization induced phase separation polymer disperse liquid crystal display was prepared. Different ratio of liquid crystal E7 (E. Merck, Germany) to Norland 65 (Norland) were mixed and sandwiched between two ITO coated glasses with a spacer of either 4.5 μm, 25 μm or 50 μm. Step wedge was used to optimize the UV-curing time under Cure Zone exposure unit (ADAC

Technologies). Figure 8a shows a typical hysteresis curve for polymerization induced phase separation PDLC prepared with the above procedure.

On page 27, after "Example 10" replace the first line and paragraph with the following (Changes have been made in the heading and line 3.):

~~SiPix~~ Sipix Hysteresis-Free Liquid Crystal Display

A single layer liquid crystal display was assembled using microcup prepared in example 1, 2 or 3. Liquid crystal with or without dichroic dye(s) was filled into microcup with procedure described in example 4, 5 ~~and~~ or 6. These LC-filled microcups were then sealed with procedure described in example 7 or 8. No hysteresis was observed for liquid crystal displays made according to the present invention. (see Figure 8b)

On page 27, after "Example 11, Assembling of multiplayer display and its performance" replace the first paragraph with the following paragraph (A change has been made in line 6.):

Multilayer liquid crystal display was assembled to improve display performance. Single layer liquid crystal display was made as described in example 10. Same procedure was used to emboss a second layer of microcup on top of the first LC display, to fill LC with or without dye and to seal the second layer of LC display. The registration of second layer microcup on the first layer was set to be off from the first layer about 0 to 10 degree to ~~maximum~~ maximize light scattering. Laminate two double-layer arrays to stack up a four-layer liquid crystal display. A high contrast display was obtained with rising and falling response time of ~1 msec and ~10 msec (at 40 volts) respectively. No hysteresis loop was observed.